On-Farm Nitrogen Network, Crop Year 2001

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Background, Partners and Description

Iowa agriculture is increasingly identified as a primary source of pollution, particularly losses of nitrogen (N) from row crop fields and associated impacts upon local and regional water quality. The form, timing and application rate of N fertilizers are management aspects that farmers have the ability to control. Effective management of these aspects may minimize negative environmental impacts and increase management efficiency, providing farmers an economic return. Recognizing the need to improve environmental performance, while improving the profitability of farmers, the Iowa Soybean Association, with support from the Iowa Department of Agriculture and Land Stewardship, crop consultants, farmer coops, Community Colleges, Iowa State University researchers and the Iowa Soybean Promotion Board, is empowering a network of over 100 Iowa farmers to evaluate, validate and demonstrate performance of on-farm nitrogen management.

The purpose of the Iowa On-Farm N Network is to enable growers to improve nitrogen management by evaluating their current practice to an alternative or modified management practice. Historic efforts to improve N management have often focused on "telling" and "showing" farmers prescriptions of better management practices (BMPs) and then convincing or incentivizing them to adopt the "BMPs". The vision of the Iowa On-Farm Network is to enable farmers to "do" evaluation of alternative practices themselves on their own farms, across entire fields (not small plots), where performance data and information they receive is real world and directly applicable to their situations. Results indicate the potential for growers to improve N management is great. Many of the common BMPs advocated by universities and agencies are generally broadened for simplicity sake and wide range of adoption. Growers doing their own evaluations can further refine their management so the room for local improvement is real. By sharing data from multiple growers in an area, the impact of these demonstrations becomes much more valuable and therefore more effective.

All of the growers involved in the On-Farm N Network have combines equipped with a global positioning system (GPS) and yield monitors. The growers were given guidance and a design protocol that is both easy to implement and will give meaningful information. The basic design is for a grower to put out replicated strips comparing two N treatments over the length of a field for at least 20 acres. One treatment is the grower's normal practice, perhaps the normalized BMP, the other being an alternative practice. The majority of the treatments for crop year 2001 were the farmers' normal N rate compared to the farmer's normal N rate less 50 lbs N/acre. By using the same type of fertilizer, the same equipment and timing, and conducting evaluation on growers' farms as opposed to research stations, the data is more meaningful to many growers.

Participants and Demonstration Sites

County	Number of Sites
Adams	2
Black Hawk	5
Boone	13
Bremer	2
Buchanan	8
Buena Vista	2
Butler	1
Cerro Gordo	2
Cherokee	2
Chickasaw	6
Dallas	2
Delaware	2
Fayette	2
Floyd	5
Franklin	3
Fremont	1
Greene	9
Grundy	2
Hamilton	1
Hancock	4
Hardin	1
Howard	7
Johnson	1
Kossuth	2
Linn	1
Lucas	1
Marshall	1
Mills	1
Mitchell	1
Osceola	3
Palo Alto	1
Story	11
Tama	3
Washington	5
Winneshiek	1
Total =	114

While most growers established a single demonstration site, several growers had more than one site. In addition, at the time of preparing this report, 9 sites had been confirmed as lost due to hail, replanted or chopped for silage. A total of 74 sites had been successfully processed, 16 were in cue for processing, and for the remaining sites, the data is still being collected from participants.

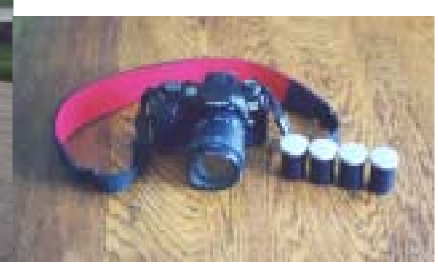
Tools Involved

GPS and Yield Monitors –

Roughly half of all new combines are equipped with yield monitors. Yield monitors, when properly calibrated and operated, give growers the opportunity to measure the yield collected over portions of a field. Adding a global positioning system (GPS) receiver to allow the yield data to be linked with a geospatial position in the field increases the information power of the yield monitor. In this project growers had both a GPS and yield monitor to collect data over the demonstration area. This permitted them to not only measure the yield differences over the entire 20 acres, but also measure differences in a smaller portion of a field with unique characteristics such as a soil type.

Aerial Photography –

Color aerial photographs were collected for the majority of sites. This involved taking color photographs with a 35 mm camera from an airplane. This type of photography has been proven capable of detecting N deficiencies in corn. These pictures can be taken before harvest to determine which portions of a field may be N stressed. This is a low-cost tool available to growers that also adds credibility to the yield differences measured by the combine. Actual examples can be seen in the case study section of this report.



Elevation Mapping –

Differences in topography account for a lot of the variation in soil types. With accurate elevation data, differences in landscape position can be quantified. Elevation data can be used to calculate other variables such as slope. All of these variables can be used to determine factors that affect the optimal amount of N required based upon different landscape positions.

Soil Conductivity –

This is a relatively new variable that some crop consultants are starting to use to measure differences in soil properties. The Geonics EM-38 has been useful in detecting differences, such as texture, in soils. The actual unit is the orange piece of equipment on a wooden sled behind the ATV.

Preliminary Results

At the time of preparing this report, 37 of the 74 sites showed growers were already applying at least 20 lbs N/acre less than recommended. Only 13 of the sites had growers applying at least 20 lbs N/acre more than recommended, and 6 of those were economically optimal above the recommended amount. Despite operating within the current BMPs available, growers involved identified an opportunity for additional improvement by adopting a self-evaluation process on their farms. Processing yield reports was still in progress. While meeting with growers, three main comments came up.

1. Some of the growers were surprised when there was little or no difference in yield between their normal practice and the reduced practices, particularly when they followed the yield goal based recommendations.
2. Some of the growers were surprised by preliminary analysis that has shown if the manure was applied but not incorporated immediately, there was a response to extra nitrogen fertilizer.
3. For sites that did show differences in yield due to N, growers discovered that it was not always the highest yielding areas that needed higher rates of N, which conflicts with the theory of yield goal based recommendations.

Grower meetings were held throughout the state during February 2002, and a statewide meeting was held in Ames on March 1, 2002. Summaries of the findings and the group discussions will be available on the World Wide Web page http://www.iasoybeans.com. In addition, more in-depth examples will be made available as the data processing is completed.

Communications and Outreach

In addition to the On-Farm N Network participants, significant outreach activities were conducted to inform other growers and the broader public about the opportunity to improve their N management. And, as results are further quantified, additional outreach efforts will be performed.

During the summer of 2001 six different N management field days were held around Iowa. These field days provided an opportunity for project partners to discuss the approach that was being taken at the demonstration site and provided a venue to discuss associated environmental issues. The following participants held demonstration field days:

John Askew hosted at Thurman, Iowa
Ray Gaesser hosted at Corning, Iowa
Jim Stillman hosted at Emmetsburg, Iowa
Dennis Lindsay hosted at Masonville, Iowa
Steve Lawler hosted at Ogden, Iowa
Ted Hamer hosted at Cedar Falls, Iowa

Radio interviews were conducted with project partners as part of the Iowa Soybean Radio Network. These taped interviews were aired on 11 radio stations across Iowa and will continue with the progression of the data analysis.

Magazine/newspaper articles have appeared in the Iowa Soybean Review, Farm Bureau Spokesman, Successful Farming, Progressive Farmer, Wallaces Farmer, Iowa Farmer Today and Farm News.

Two sessions focusing on the On-Farm N Network were covered during the ISU Iowa Crop Management Conference.

Crop Fairs were held featuring presentations about the On-Farm N Network. These Crop Fairs were hosted and sponsored by the Iowa Soybean Promotion Board and local area cooperatives.

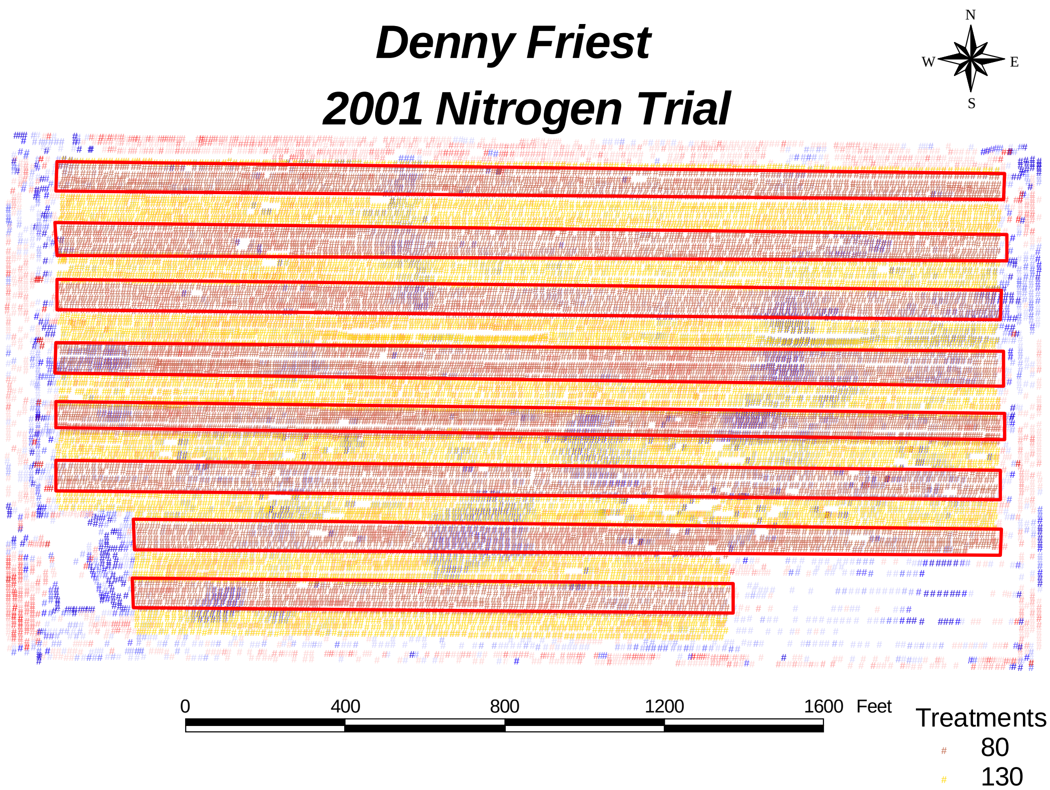
With the first year of the project wrapping up and with relevant results and data now becoming available, the first of six newsletters was published in February. The newsletters will focus on the findings of the program and will be used to inform not only growers, but key individuals in agricultural business organizations, grower organizations, and other agencies who work with growers on nutrient management.

Case Study #1

Cooperator Denny Friest
Location: Radcliffe, Iowa (central Iowa)

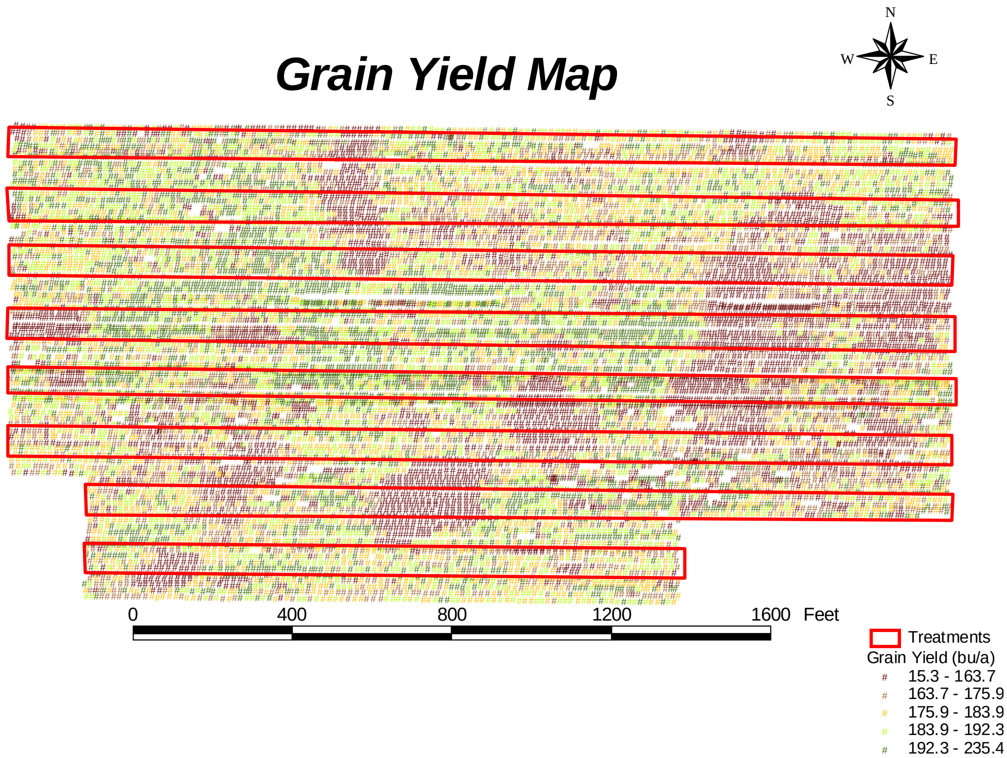
Trial: Comparing 130lb N acre to 80lb N/a
(Does not reflect 20 lb N/a added with DAP)

Result: A rate lower than that prescribed by yield goal based recommendations was more profitable over entire field.



This trial was larger than many in size to increase the sensitivity of comparing N rates. The field average was 176 bu/a. Using a yield goal based recommendation, you would calculate 176 * 1.2 – 45 = 151 lb N/a. Friest had already applied 20 lb N/a with his P applications and accounted for this by applying his 130 lb N/a + the 20 lb N/a already applied. To determine if he could lower his rates, Friest reduced his rate to 80 lbs N to see what would happen, because he knew that he would be compensated for any yield loss.

Case Study #1 continued



The end result is:

*Farmer normal practice	= 150 lb N/a	= 176.8 bu/a
Farmer alternative practice	= 100 lb N/a	= 175.6 bu/a
Difference	= 50 lb N/a	= 1.2 bu/a

*Yield goal based recommendations would call for 151 lb N/a.

If you assume 50 lbs N @ $0.17 / lb = $8.50/a and 1.2 bu @ $2.00 / bu = $2.40, the net savings would be $6.10/a with the reduced rate of nitrogen.

It should be noted that 1.2 bushel difference is small; and, therefore, the majority of the field may have been optimized with even less N than the reduced rate that was applied. Stalk nitrate samples collected from various locations in the field helped document the relative N sufficiency of the reduced rate in different environments within the field.

Summary Statement: This grower followed the best recommendations he had available to him. Following those recommendations he found that he had the opportunity to further improve his management. Although he is still reluctant to change all his practices without more data, he is now going to spend more of his efforts evaluating his current practices to improve his management.

Case Study #2

Cooperator Ray Gaesser
Location: Corning, Iowa (southwest Iowa)

Trials: Three N rates (50, 100, and 150) replicated three times. This was done on corn following corn on the north side of the field and corn following soybean on the south end of the field.

Results: Corn following soybeans required higher N fertilizer rate than corn following corn. The lower yield portions of the field required more N than higher yielding areas of the field.

The end result is:

		Corn – Corn	Corn-Soy
*Farmer normal practice	= 150 lb N/a	= 140.5 bu/a	143.0 bu/a
Farmer alternative practice	= 100 lb N/a	= 143.2 bu/a	136.9 bu/a
Added Treatment	= 50 lb N/a	= 127.7 bu/a	128.1 bu/a
Difference between 150 and 100 lb N /a		-2.7 bu/a	6.1 bu/a

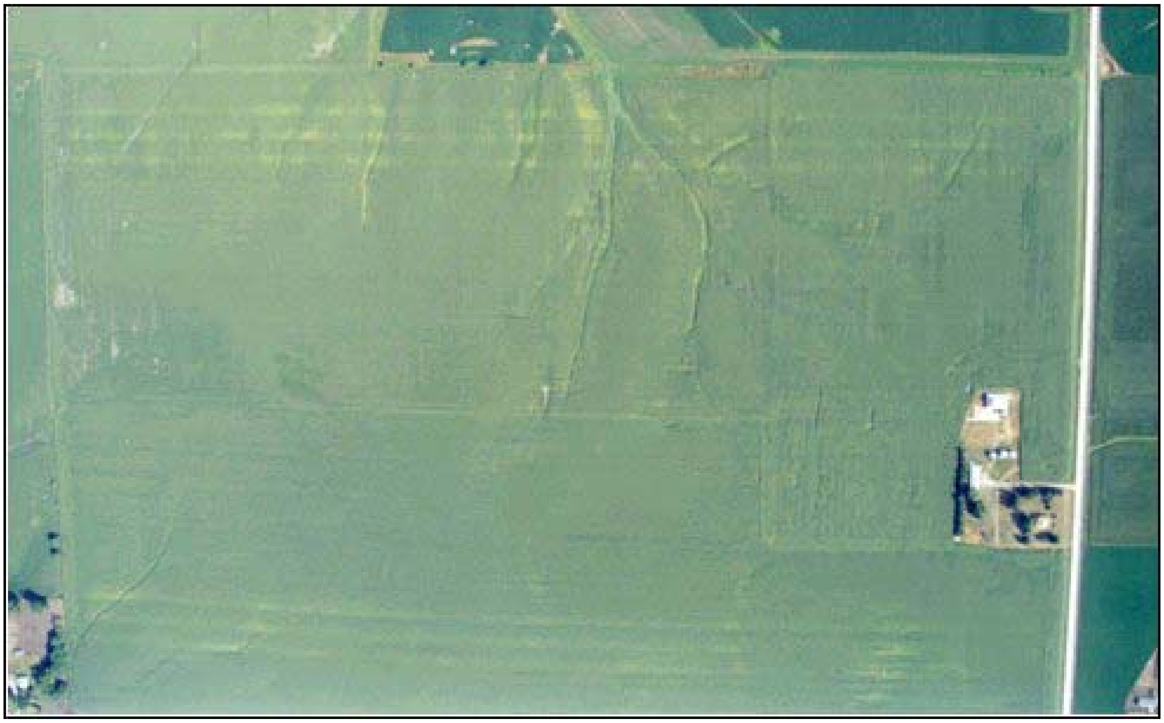
*A normalized yield goal based recommendation would call for 170 lb N/a. for corn on corn and 124 lb N/a for the corn after soybean.

If you assume 50 lbs N @ $0.17 / lb = $8.50/a, the corn on corn trial, the farmer would save $8.50 per acre from his normal practice or $11.90 /a compared to yield goal based recommendation. In addition, spatial analysis shows many portions of the field were optimized at 50 lb N/a if the farmer was able to manage the field spatially. For the corn after soybean trial, the 150 lb N/a treatment resulted in a 6.1 bu @ $2.00 / bu = $12.20 yield advantage which was reduced to a $3.70 profit after paying for the fertilizer.

In addition to the basic field trials, additional data was collected on this field to better understand the portions of a field that need additional or reduced amounts of N. This field was selected for additional data collection because of the lower N rates and the observed differences in yield. These spatial differences in yield can be related to other factors to help the grower identify portions of a field the may need less N than other areas.

Case Study #2 continued

Figure 1. Color Aerial photograph of Ray Gaesser Field Demonstration



The color aerial photo taken of the field shown above contains both trials. The corn after corn trial is near the top of the image and the corn after soybean in near the bottom. In both trials, the yellow streaks can be seen for the 50 lb N/a treatments. Notice how these patterns change spatially.

When comparing the areas showing N stress to some of the later figures, not only the spatial variability of the trial, but also which other factors like slope or soil type explain the yield differences.

Case Study #2 continued

Figure 2. Bare Soil Photo of Demonstration Area

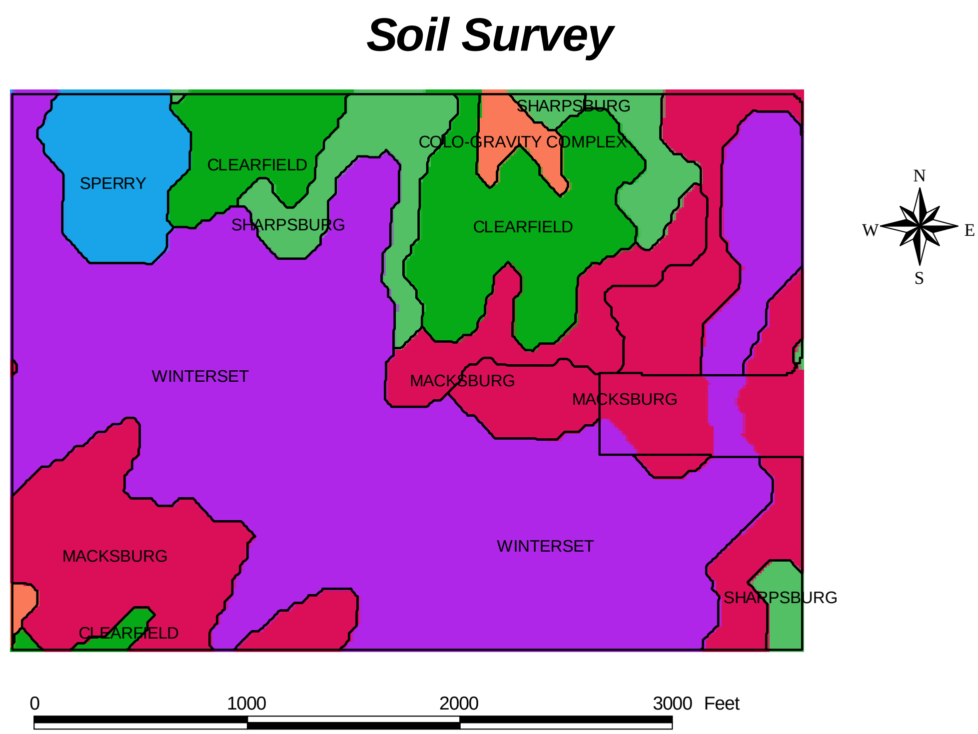
This image was collected in the spring of 1990 and was ordered from the USDA Farm Services Agency office of aerial photography. This image is helpful in identifying differences in soil based upon both soil color and position of waterways. Note in both the color photo and the grain yield maps, the areas around the waterways tend to be the lowest yielding areas and tend to be most N deficient.

These photographs are archived back to the 1950's and can help give growers some historical information about the fields. Many of the fields, such as this 240-acre field, were previously farmed as separate fields. If you look carefully, you will note the upper right hand corner of the field is different. This was because the field was managed separately before and those differences are reflected in both the yield map and the difference in yield of the lowest N rate in the upper right hand corner of the field.

Growers can collect more recent bare-soil photos for a low cost that can be used to assess the differences in soil organic matter. Organic matter is one of the most important variables in assessing N fertilizer requirements for a corn crop.

Case Study #2 continued

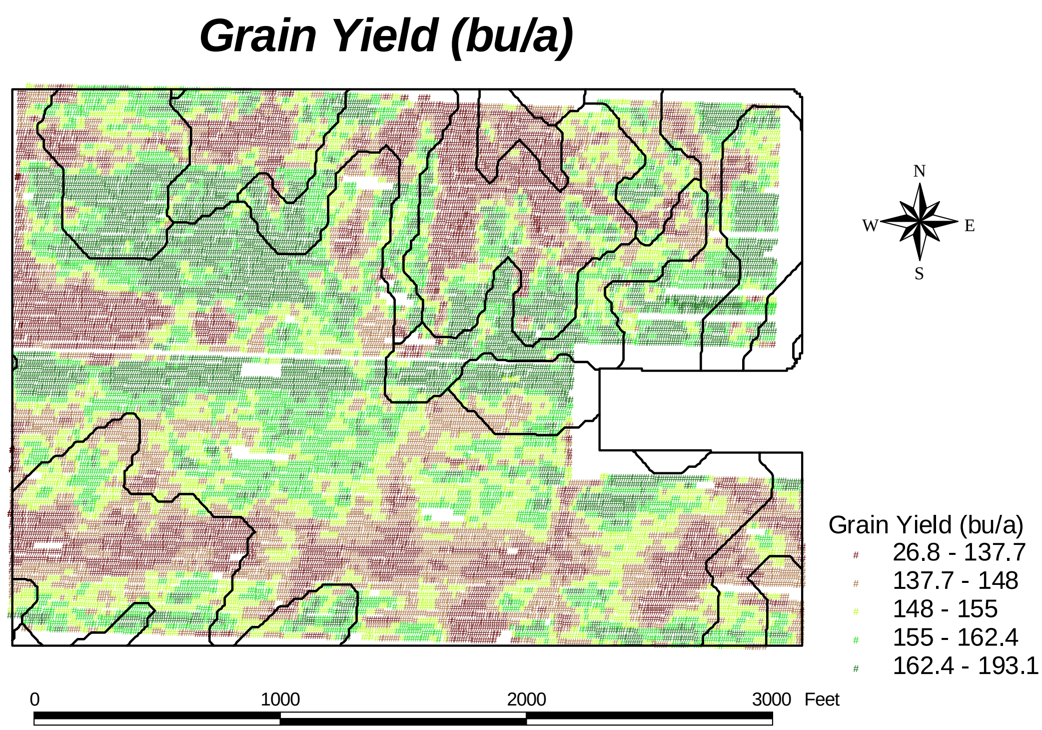
Figure 3. Soil Survey of Demonstration Area



With the new technologies that many growers possess, the growers do not need to think of a field as a single management unit. Farmers are familiar with soil surveys and now they can use these soil surveys to strategically position their on-farm trials across a range of soil types. They can then evaluate for themselves which soil types may need more or less N. In this demonstration, the grower positioned his trials to deliberately go across the widest range of soil types he had.

Case Study #2 continued

Figure 4. Grain Yield Map

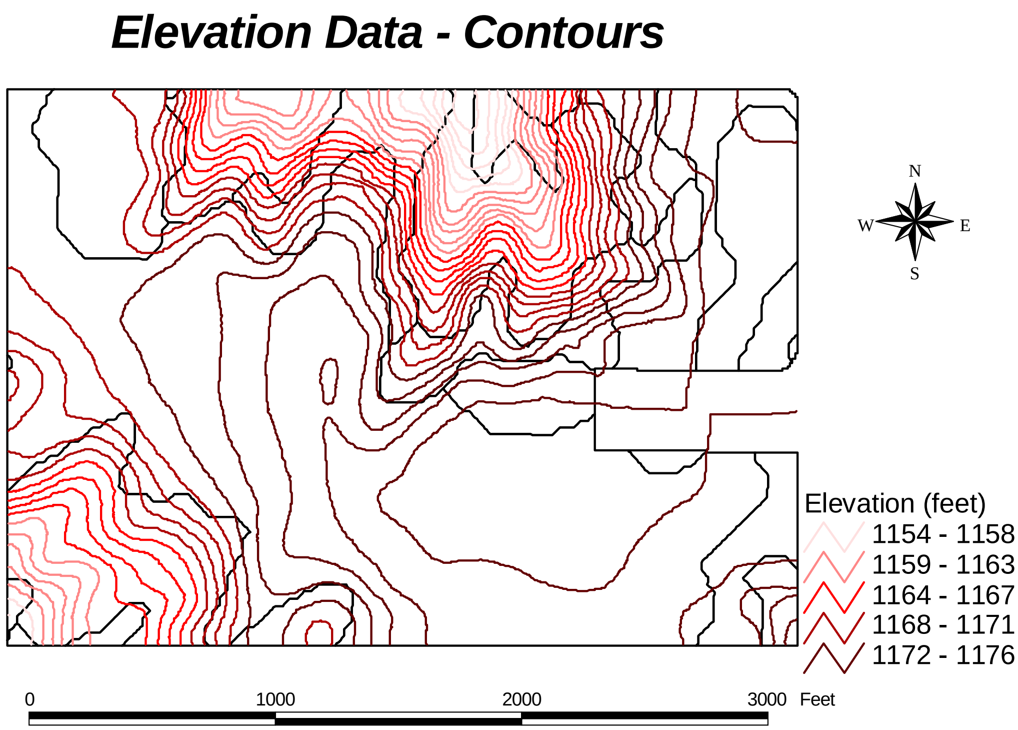


This a grain yield map made from data collected with combine equipped with a GPS and yield monitor. The black lines are the boundary of the different soil types defined in Figure 3. The green color represents are of higher yield and the brown colors represent lower yielding areas of the field. Notice that yield patterns show some relation to the soil types but are collected at a finer detail. Also notice the lower yields for the test on the south end of the field which was the corn following soybean trial. You can see the majority of the trial area having reduced yields as compared the corn following corn trial on the north end (see the aerial photo in Figure 1).

While the yield maps are interesting, the interpretation of the yield map itself as it relates to the N test strips takes additional processing that leads to the summaries presented at the beginning of this case study. In addition, more analysis is needed to relate the differences in yield resulting from the N test strips compared to other data layers such as the slope, elevation and soil conductivity (shown in the following figures).

Case Study #2 continued

Figure 5. Elevation Map

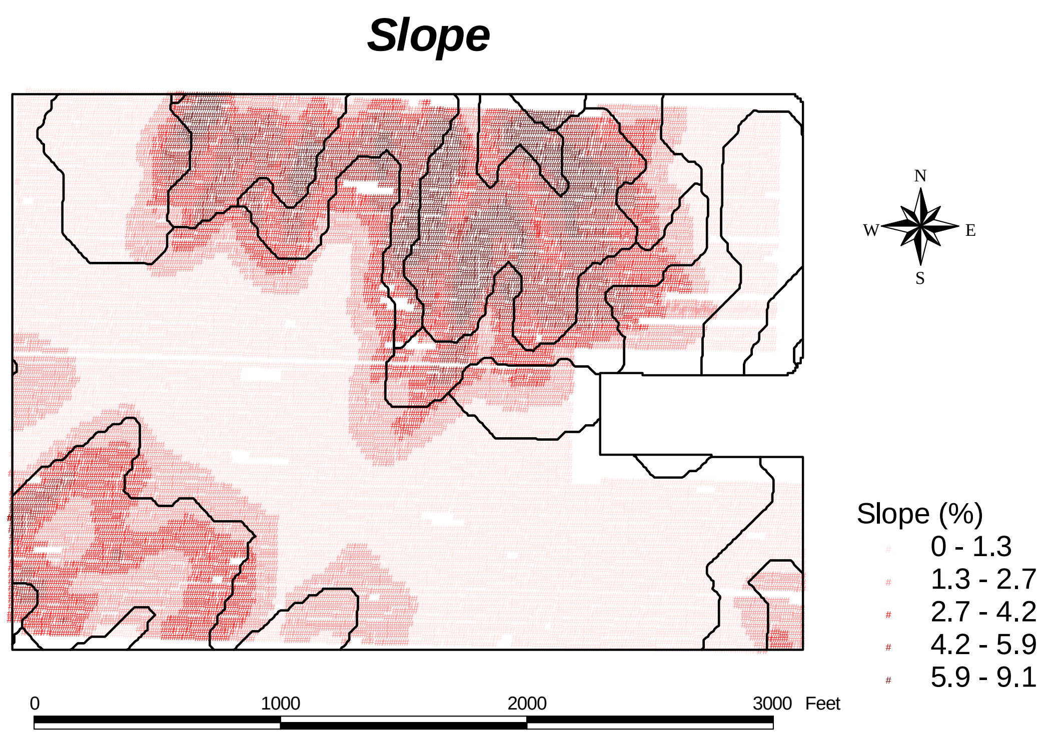


This is an elevation map made from data collected with a survey grade GPS. The black lines are the boundary of the different soil types defined in Figure 3. Each contour line is a foot difference in elevation. The darker the color, the higher position in the field. The relative position of the soil on the landscape has a major influence on the soil formation and weathering.

The areas with the lines closer together represent a steeper slopes and therefore more eroded soils. The actual slope can be calculated from the elevation data as was done in Figure 6.

Case Study #2 continued

Figure 6. Slope Map

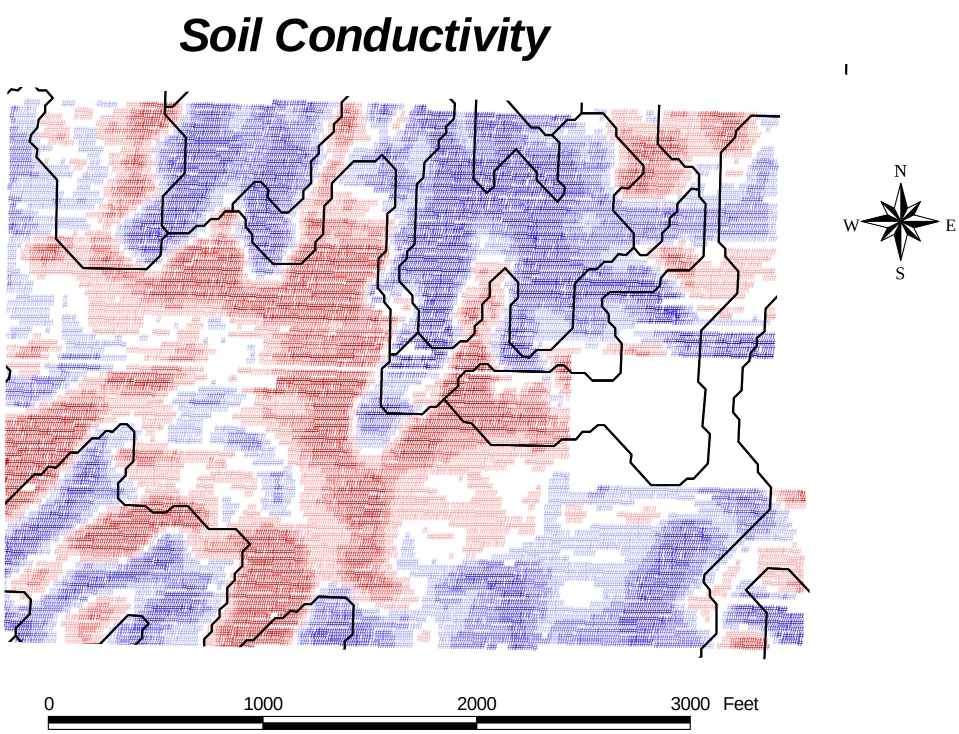


This is a slope map made from the elevation data collected with a survey grade GPS. The black lines are the boundary of the different soil types defined in Figure 3. The darker the color is, the steeper the slope. The relative position of the soil on the landscape has a major influence on the soil formation and weathering. The steeper the slope, there exists greater potential for soil erosion. Comparing the degree of slope with the degree of N stress (most easily seen in the color photo in Fig.1) shows that the areas with higher slopes tend to also be the areas with N stress.

It is interesting to note that these were the lower yielding regions of the field and yet had the highest N fertilizer requirement. This directly disputes the theory of yield goal based recommendations.

Case Study #2 continued

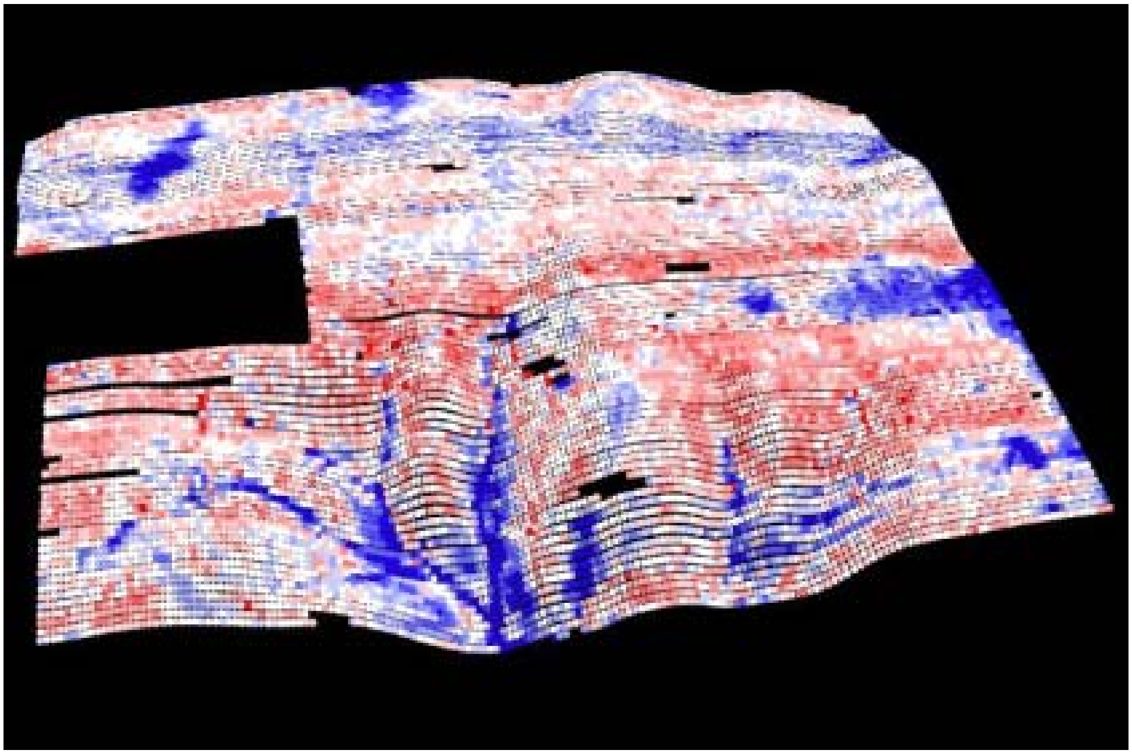
Figure 7. Soil Conductivity Map



This is a soil conductivity map that shows the difference among soils, such as texture. From this example, you can see that the soil conductivity roughly follows the patterns shown by the black lines that represent different soil types. You can see the patterns are better defined by the differences in color. Although these differences in soil can be mapped, this in itself does not give information on how to manage them. Using data like soil conductivity combined with the yield response data to field treatments can help identify improved nutrient management practices.

Case Study #2 continued

Figure 8. Grain Yield Draped over Elevation Map



This figure is the grain yield map draped over the elevation data. The blue color represents the lower yielding areas and the red represent higher yielding areas. This image is rotated so the corn-on-corn trial is on the bottom of this image. You can see from this example the blue streaks in the lower right-hand corner of the field. Those streaks represent the 50 lb N/a treatment, which shows the largest yield difference occurred on the side slopes. It also shows that it was the lower yielding portions of the field. Also note, on the left-hand side of the image that the higher yielding areas of the field do not show the difference in treatments, which means it needed less N.